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ABSTRACT

This paper provides instructions for linking conceptual understandings using the Connections Matrix. The Connections Matrix and the process of connecting the curriculum works equally well with state-level learning objectives or outcomes. The intent of this process is to help educators see the overlap and connections between what teachers say they teach and what, in reality, students need to experience. In addition, educators need to be reminded of the idea that students do not learn in isolation; bits of information connected to other bits of information help students remember and learn. Finally, by connecting the curriculum through national standards in science and mathematics, teachers provide better opportunities for future teachers to approach teaching in a thorough and meaningful manner. A checklist for connecting the curriculum is provided. (CCM)

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Connecting the Curriculum through National Science and Mathematics Standards: A Matrix Approach

by
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CONNECTING THE CURRICULUM THROUGH NATIONAL SCIENCE AND MATHEMATICS STANDARDS: A MATRIX APPROACH

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Curriculum Integration at the National Level

The need for both a connected curriculum and the implementation of the national mathematical and science standards is acknowledged by organizations and content experts throughout the educational system. Organizations including the National Council of Teachers of Mathematics, National Science Teachers Association, American Association for the Advancement of Science, Association for the Education of Teachers of Science, the Association for Supervision and Curriculum Development, and many others have sponsored publications indicating the need for, and benefits of, both the connected curriculum and the national standards in mathematics and science.

Connecting the curriculum is a phrase used far and wide by educators and researchers alike. It has many meanings and many different levels of implementation. For this work it is intended to mean the linking of conceptual understandings denoted by the National Council of Teachers of Mathematics (1998) in their publication *Standards 2000 Project* (draft) and the National Research Council's (NRC) National Science Education Standards (1995). Although each document approaches the topic from a slightly different

perspective. Both indicate the need for connections to build understanding and learning by students.

The connected curriculum leads to more time spent on active student learning, increased retention of conceptual ideas, increased practice time, and greater potential for student application in all content areas. The connections build upon each other and make the process and the learning more powerful to the individual.

Intervention: The Connections Matrix

The process for connecting the curriculum is simple and effective. The Connections Matrix, first published in JSTE (1996) is a grid format which allows educators to examine the content standards and components of two different content areas and discover the areas where the two mesh together. First one content standard is defined, then the other is defined, and then the connections are identified.

Completing the Connections Matrix

To complete the Connections Matrix, select one of the national standards, either mathematics or science. For this work science will be examined first. Then select a standard which has a particular meaning or importance to your classroom curriculum. For this example Content Standard B:5-8,Physical Science from the *National Science Education Standards* (NRC, 1995) has been selected. This standard reveals that, "as a result of student activity in grades 5-8, all students should develop an understanding of

the properties and changes of properties of matter, motion and forces, and transformations of energy."

Next, identify three critical components of the standard which students must understand in order to be able to demonstrate an attainment of the standard. For this example these components could include: A) understanding properties and changes in properties of matter, B) understanding motion and forces, and C) understanding transformations of energy. These are the components used to build the connected curriculum. These components are recorded on Chart 1.

The same process should be repeated with the mathematics standards. For this example Standard 2 of Principles and Standards for School Mathematics: Draft Discussion (1998) by NCTM is used. Standard 2 includes: Mathematics instructional programs should include attention to patterns, functions, symbols, and models so that all students understand various types of patterns and functional relationships; use symbolic forms to represent and analyze mathematical situations and structures; mathematical models and analyze change in both real and abstract contexts.

The three components of this standard could include: 1) exploring relationships between symbolic expressions and graphs, 2) become fluent in generating equivalent expressions for simple algebraic expressions and in solving linear equations and inequalities, and 3) use symbolic algebra to represent situations and to solve problems.

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especially those that involve linear relationships (NCTM - Draft, 1998). These components are recorded on Figure 1.

Figure 1 demonstrates the format for developing the matrix used to connect the curriculum. The matrix allows the user to decide upon the standards to be used and then select connecting activities which help students learn about each standard in each content area by actively participating in learning experiences which fit into both content areas and are designed to align with the content standards. Additional samples of completed versions of the Connections Matrix are located on the World Wide Web (www.oit.cmich.edu/rfrancis/research/).

Selecting the Learning Events and Activities

Once the parameters of the Connections Matrix have been selected, it is time to identify learning experiences that are appropriate to the developmental level of the students involved in the class. First examine Cell A1. Read the two components listed and brainstorm the possible activities through which students could learn about both components. Only spend two to three minutes brainstorming about any one cell, and then move on to the next cell. By the time you finish you will have identified nine, and probably more, activities which students can complete which will help them learn about the identified goals and objectives.

Figure 1. The Connections Matrix

Science ⇒ ⇓ Mathematics	A. understanding properties and changes in properties	B. understanding motion and forces of matter	C. understanding transformations of energy
1. exploring relationships between symbolic expressions and graphs	A1	B1	C1
2. become fluent in generating equivalent expressions for simple algebraic expressions	A2	B2	C2
3. use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships	A3	B3	C3

Summary

The national standards in mathematics and science are a reality. As teacher educators we must position our future teachers to enable them to deliver a meaningful and effective curriculum in science. To do this we must make use of mathematics in the science curriculum. It follows that science is the context in which we learn mathematics,

and that mathematics is the language of science. The two are forever connected, and should be approached as both a knowledge base and an application of process skills.

The Connections Matrix and the process of connecting the curriculum works equally well with state level learning objectives or outcomes. The intent of the process is to help educators see the overlap and connection between what we say we teach and what, in reality, students need to experience. As educators we need to be reminded of the idea that we do not learn in isolation. Bits of information connected to other bits of information help us to remember and learn. By connecting the curriculum through the national standards in science and mathematics we are providing better opportunities for our future teachers to approach teaching in a thorough and meaningful manner. By using the Connections Matrix process to connect science and mathematics we are enabling teachers to create and deliver such a curriculum.

References

National Council of Mathematics. (1998). *Standards 2000 Project* (draft) taken from www at http://www.nctm.org/standards2000/ on January 11, 1999.

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Review of connections matrix steps

1. identify a standard in a content area

2. identify three critical components of the standard

3. list the critical components on the Connections Matrix

4. identify a standard from a second content area

5. list three critical components of the standard

6. list these three critical components on the Connections Matrix

7. brainstorm possible learning events

8. select the most appropriate learning events